While in the embodiment described in Fig. 11, the compensation channel 27 has been illustrated as a portion of the microchannel structure 21, it will be appreciated that the liquid outlet 12 could be so arranged that itself had a recirculation conduit adjacent the liquid outlet such as to balance the flow rates.

The delivery of the sample to microfluidic microchannel structures can be a difficult task. Typically, in the microfluidic system, the diameter of the microchannels is in the order of magnitude lower or more than the diameter of the inlet port and tubing delivering the sample. To allow optical observation of biological samples, the linear velocity of the fluid inside the channel should be relatively small, in the range of micrometers/sec.

Referring now to Fig. 12, substantially the same method can be used in the case where a wider microchannel 22 is connected to a narrower microchannel 28 which will cause the concentration of the narrow channel to be less than the initial concentration of cells in the wider channels. This will happen again due to the aggregation of cells around the input from the wider channel 22 into the narrow channel 28 or by settlement along the channel 22. This can be overcome by the use of a further compensation channel 27 such that the cross sectional area of the compensation channel 27 and the narrow channel 28 equal the cross sectional area of the wider microchannel 22.

In the specification the terms "comprise, comprises, comprised and comprising" or any variation thereof and the terms "include, includes, included and including" or any variation thereof are considered to be totally interchangeable and they should all be afforded the widest possible interpretation.

The invention is not limited to the embodiments hereinbefore described but may be varied in both construction and detail.

CLAIMS

1. A liquid outlet link assembly to provide a steady liquid delivery output rate below 10µl/minute through a liquid outlet means from a positive displacement pump having an immediate step pumping rate which is

relatively substantially larger than the delivery rate through the liquid outlet means comprising:-

a body having a hollow interior with a resistance to flow therethrough substantially less than through the liquid outlet means;

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body for connection to the liquid outlet means; and

pressure activated expansion means in the body to create a liquid pressure at the liquid outlet to provide the desired liquid delivery flow rate through the liquid outlet means.

2. An assembly as claimed in claim 1, in which the expansion means comprises a gas bubble.

3. An assembly as claimed in claim 2, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

4. An assembly as claimed in claim 2, in which the expansion means comprises more than one gas bubble and the aggregate volume of the bubbles is a multiple of the volume of liquid dispensed in one step of the pump.

5. An assembly as claimed in claim 2, in which the liquid outlet means comprises an elongate microchannel structure, the liquid pressure is such as to provide the necessary liquid pressure gradient between an entry port formed by the proximal end of the microchannel structure for connection to the liquid outlet and an exit port formed by the distal end of the microchannel structure.

6. An assembly as claimed in claim 2 in which control means are provided, the control means comprising:-

means for sensing the flow conditions within the liquid outlet means; and

means for causing the pump to operate in response to the sensed flow conditions.

7. An assembly as claimed in claim 1, in which the pressure activated expansion means comprises an elastic membrane forming part of the body member.

8. An assembly as claimed in claim 1, in which the body comprises expandable tubing which forms the expansion means.

9. An assembly as claimed in claim 1, in which the liquid outlet means comprises an elongate microchannel structure, the liquid pressure is such as to provide the necessary liquid pressure gradient between an entry port formed by the proximal end of the microchannel structure for connection to the liquid outlet and an exit port formed by the distal end of the microchannel structure.

10. An assembly as claimed in claim 1, in which control means are provided, the control means comprising:-

means for sensing the flow conditions within the liquid outlet means; and

means for causing the pump to operate in response to the sensed flow conditions.

11. An assembly as claimed in claim 1, in which the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the liquid outlet means are substantially equal.

12. An assembly as claimed in claim 1, in which the liquid outlet in the body includes a recirculation pipe connected between the liquid outlet and the body.

13. A liquid outlet link assembly to provide a steady liquid delivery output rate below 10µl/minute through a liquid outlet means from a positive displacement pump having an immediate step pumping rate which is relatively substantially larger than the delivery rate through the liquid outlet means comprising:-

a body having a hollow interior with a resistance to flow therethrough substantially less than through the liquid outlet means;

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body for connection to the liquid outlet means; and

a gas bubble in the body to create a liquid pressure at the liquid outlet to provide the desired liquid delivery flow rate through the liquid outlet means.

14. An assembly as claimed in claim 11, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

15. An assembly as claimed in claim 11, in which the liquid outlet means comprises an elongate microchannel structure, the liquid pressure is such as to provide the necessary liquid pressure gradient between an entry port formed by the proximal end of the microchannel structure for connection to

the liquid outlet and an exit port formed by the distal end of the microchannel structure.

16. An assembly as claimed in claim 11, in which the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the liquid outlet means are substantially equal.

17. An assembly as claimed in claim 1, in which the liquid outlet in the body includes a recirculation pipe connected between the liquid outlet and the body.

18. A pump assembly to provide a steady liquid delivery output rate below 10 µl/minute comprising:-

a positive displacement pump;

a motor to operate the pump in a stepped manner such that the pump has an immediate step pumping rate which is relatively substantially larger than the liquid delivery output rate;

a liquid outlet means for the pump assembly;

a liquid outlet link assembly comprising:-

a body having a hollow interior with a resistance to flow therethrough substantially less than through the liquid outlet means;

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body for connection to the liquid outlet means; and

pressure activated expansion means in the body to create a liquid pressure at the liquid outlet to provide the desired liquid delivery flow rate through the liquid outlet means.

19. A pump assembly as claimed in claim 18, in which the expansion means comprises a gas bubble.

20. A pump assembly as claimed in claim 18, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

21. A pump assembly as claimed in claim 18, in which the expansion means comprises more than one gas bubble and the aggregate volume of the bubbles is a multiple of the volume of liquid dispensed in one step of the pump.

22. A pump assembly as claimed in claim 18, in which the pressure activated expansion means comprises an elastic membrane forming part of the body member.

23. A pump assembly as claimed in claim 18, in which the liquid outlet means comprises an elongate microstructure, the liquid pressure is such as to provide the necessary liquid pressure gradient between the entry port formed by the proximal end of the microstructure and the exit port formed by the distal end of the microstructure.

24. A pump assembly as claimed in claim 18, in which control means are provided, the control means comprising:-

means for sensing the flow conditions within the liquid outlet means; and

means for causing the pump to operate in response to the sensed flow conditions.

25. A pump assembly as claimed in claim 18, comprising:-

optical flow monitoring means connected to the liquid outlet means; and

control means connected to the optical flow monitoring means and the pump to operate the pump to provide the desired flow rate through the liquid outlet means.

26. A pump assembly as claimed in claim 18, comprising pressure sensing means in the liquid outlet means and control means for operative connection to the positive displacement pump to cause the pump to operate on the pressure falling below a predetermined level.

27. A pump assembly as claimed in claim 18, in which the pump is a syringe pump.

28. A pump assembly as claimed in claim 18, in which the volume pumped for each step of the syringe pump is greater than 0.1 μl.

29. A pump assembly as claimed in claim 18, in which the volume pumped for each step of the syringe pump is of the order of 0.2 μl.

30. A pump assembly as claimed in claim 18, comprising at least two syringe pumps feeding the one liquid outlet link assembly.

31. A pump assembly as claimed in claim 18, in which the volume dispensed by at least one of the pumps for one step of that pump is substantially less than that of the other pumps.

32. A pump assembly as claimed in claim 18, in which at least one additional electrokinetic pump is provided.

33. A pump assembly as claimed in claim 32, in which the electrokinetic pump is an electroosmotic pump.

34. A pump assembly as claimed in claim 32, in which the electrokinetic pump is an electrohydrodynamic pump.

35. A pump assembly as claimed in claim 18, in which the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the liquid outlet means are substantially equal.

36. A pump assembly as claimed in claim 18, in which the liquid outlet of the body includes a recirculation pipe connected between the liquid outlet and the body.

37. A microchannel structure assembly for the controlled flow of small volumes of liquids comprising:-

an elongate enclosed microchannel structure having an internal bore less than 1000 μm^2 cross-sectional area;

a positive displacement pump operating in a series of steps, each step operation of the pump dispensing a volume of the order of 0.01 μl;

a liquid outlet link assembly comprising a body having a hollow interior with a bore considerably larger than the microchannel structure bore and thus preventing a resistance to flow therethrough substantially less than through the microchannel structure;

a liquid inlet in the body of the link assembly for connection to the pump;

a liquid outlet in the body of the link assembly for connection to the microchannel structure; and

pressure activated expansion means in the body of the link assembly to create a liquid pressure at the liquid outlet to provide the desired liquid delivery output rate from the liquid outlet means.

38. A microchannel structure assembly as claimed in claim 37, in which the expansion means comprises a gas bubble.

39. A microchannel structure assembly as claimed in claim 37, in which the volume of the gas bubble is multiple of the volume of liquid dispensed in one step of the pump.

40. A microchannel structure assembly as claimed in claim 37, in which the expansion means comprises more than one gas bubble and the aggregate volume of the bubbles is a multiple of the volume of liquid dispensed in one step of the pump.

41. A microchannel structure assembly as claimed in claim 37, in which at least portion of the body of the link assembly is expandable tubing which forms the expansion means.

42. A microchannel structure assembly as claimed in claim 37, in which the pressure activated expansion means comprises an elastics membrane forming part of the body member.

43. A microchannel structure assembly as claimed in claim 37, in which control means are provided, the control means comprising:-

means for sensing the flow conditions within the liquid outlet means; and

means for causing the pump to operate in response to the sensed flow conditions.

44. A microchannel structure assembly as claimed in claim 37, comprising:-

optical flow monitoring means connected to the liquid outlet means; and

control means connected to the optical flow monitoring means and the pump to operate the pump to provide the desired flow rate through the liquid outlet means.

45. A microchannel structure assembly as claimed in claim 37, comprising pressure sensing means in the liquid outlet and control means for operative connection to the positive displacement pump to cause the pump to operate on the pressure falling below a predetermined level.

46. A microchannel structure assembly as claimed in claim 37, comprising at least two syringe pumps feeding the one liquid outlet link assembly.

47. A microchannel structure assembly as claimed in claim 37, in which the volume dispensed by at least one of the pumps for one step of that pump is substantially less than that of the other pumps.

48. A microchannel structure assembly as claimed in claim 37, in which the pump is a syringe pump.

49. A microchannel structure assembly as claimed in claim 37, in which at least one additional electrokinetic pump is provided.

50. A microchannel structure assembly as claimed in claim 49, in which the electrokinetic pump is an electroosmotic pump.

51. A microchannel structure assembly as claimed in claim 49, in which the electrokinetic pump is an electrohydrodynamic pump.

52. A microchannel structure assembly as claimed in claim 37, in which adjacent the liquid outlet of the liquid outlet link assembly, there is provided

a flow balancing conduit, the cross-sectional area of the body adjacent the inlet substantially equaling the aggregate cross-sectional area of the microchannel structure and the recirculation conduit.

53. A microchannel structure assembly as claimed in claim 37, the liquid outlet in the body includes liquid take-off means whereby the flow rates of the liquid in the liquid link assembly and the microchannel structure are substantially equal.

54. A microchannel structure assembly as claimed in claim 37, in which the liquid outlet of the body includes a recirculation pipe connected between the liquid outlet and the body.